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Study on the use of information technology in small ports

Report by the UNCTAD secretariat

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Introduction

1. At UNCTAD X, the secretariat was requested to continue to assist developing countries in dealing with problems related to the provision of international transport services to enable them to participate more effectively in the globalization process. In particular, work in the field of management information systems applied to the transport sector should continue. Excessive transport costs create a major barrier to foreign markets. Ports play an essential role in facilitating international trade providing the link between maritime and inland transport. A country's trade will become more effective by reducing the length of time that goods and ships spend in port. In the past, UNCTAD's work in this area has focused on improving the performance of existing facilities through the preparation and distribution of studies, technical reports, group training and field projects. The purpose of this study is to provide guidance to port managers on those areas where information technology could best be used in small ports.

2. In the early 1990s, the UNCTAD secretariat prepared two studies[1] that provided advice to port managers on the use of computers and on computerized information systems for port operators. Since the invention of the microprocessor in 1971, the processing power of a silicon chip has doubled every 18 months and scientists believe this progress will continue at least to 2010. Thus in the space of 10 years, since the previous studies, computing power has increased over 64 times. At the same time, computing costs have been substantially reduced.

Table 1

Effect on cost of evolution of computing power and speed

(in US$)

	1970	1999
Cost of 1 MHz processing power	7 601	0.17
Cost of 1 Megabyte storage	5 257	0.17
Cost of sending 1 trillion bits	150 000	0.12

Source: The Bank Credit Analyst, Federal Reserve Bank of Dallas.

As table 1 depicts, the speed and capacity of computing networks have increased and transmission costs have plunged. While the systems described are still relevant, what has changed drastically in the course of the last decade has been the development of telecommunication networks that facilitate the exchange of information based on the success of Internet standards and protocols. It is these developments, allowing everyone to connect with everyone else, that enable transport operators to increase their productivity, reduce documentation costs and speed up the movement of cargo. However, for improved hardware to translate into productivity gains, appropriate software and trained staff are essential.

3. UNCTAD, through its technical cooperation activities, has two complimentary programmes to assist developing countries make greater use of information technology to speed-up the flow of goods. The first is the Customs Reform, Modernization and Automation Programme (ASYCUDA) which speeds-up the customs clearance process through computerization and simplification of procedures. In Ghana and Mauritius, average customs clearance times have been substantially reduced from one week to half a day. Overall, more

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[1] UNCTAD, *Guidelines for port managers on the use of computers* (TD/B/C.4/AC.7/11), 1990 and UNCTAD, *Computerized information systems for port operations* (TD/B/C.4/AC.7/11/Supp.1), 1991.

than 60 countries are now using the system on a regular basis. The second programme called Advance Cargo Information System (ACIS) improves transport efficiency by tracking equipment and cargo along the transport modes and at interfaces, providing information in advance of cargo arrival. This programme, originally implemented in the rail system, has allowed management to significantly reduce transit time of goods, make better use of transport equipment and improve the quality of transport services. Work is progressing on the development of addtional applications for ports.

4. At the UNCTAD Conference on Partners for Development organized in Lyon in November 1998, a session was held on *Speeding up the global movements of goods*. Cargo moving through ports in some developing countries is often delayed because of missing or insufficient information that prevents the planning of operations and blocks the speedy clearance of cargo. The quality of port services can be greatly improved using information technology and modern communication methods. However, smaller ports[2] in developing countries lack the revenue base that would allow them to make major investments for sophisticated software solutions. With the availability of high performance computing power at low cost, what is required is appropriate software that is international, multi-modal and open. UNCTAD has completed work on improving port performance and the development of low cost software for transport systems. As such, it has the expertise to assist in the development of applications using information technology making use of international standards that can be used by such ports.

5. The objective of this study is to identify areas where the use of information technology would be of greatest benefit to ports, particularly small ports in developing countries. Relevant systems will be described so those concerned officials in developing countries will be aware of their scope and benefit. The first priority for such systems should be to reduce the time cargo is immobilized in ports. The second priority should be to reduce the turnaround time of ships in port. It is evident that all ports, regardless of size and throughput should be using information technology as a means of increasing productivity. The use of text processing, spreadsheets and databases on personal computers will allow port organisations to reduce the cost of processing information and provide more comprehensive and timely information. For example, in northern Somalia in the ports of Berbera and Bossaso, personal computers are used to prepare invoices, update accounts and maintain information for statistical reporting. This simple start has allowed the two port organizations to provide better client service.

I. Information-based problems in ports

6. A number of recurring port problems are related to either a lack of information or delays in receiving information. Ports in developing countries are often more likely to encounter the following type of problems:

Port authorities and operators lack information on ships and cargo scheduled to arrive, preventing them from doing pre-arrival operational planning and preparation of administrative arrangements for the ship call.

Port authorities lack information required for billing services provided to the ship and cargo, causing cargo delivery delays.

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[2] While it is subjective to define the characteristics of a small port, the study will assume a small port is one having up to three berthing points, one gate complex, up to three transit sheds, handling up to 200 ship calls and 100,000 tonnes of breakbulk and containerized cargo per year. Many of these ports will already have a number of PCs connected to the Internet.

Port operators lack information on the location of cargo within the port, delaying cargo delivery for import cargo and slowing ship-loading operations for export cargo.

Shippers freight forwarders lack information and documents required to clear their cargo, delaying cargo delivery.

Inland transport operators lack information on cargo that is available for delivery, leading to delays in allocating equipment and cargo.

Port authorities operators lack information on cargo arriving by road and rail, leading to delays in the receipt of goods and to inland transport equipment.

A questionnaire was developed to quantify problems related to information delays and the use of IT in a number of small ports in developing countries. Although the number of respondents was disappointing, it is promising to note several of these ports have e-mail addresses, indicating Internet connections. Over a two-year period, the Port Management Association of West and Central Africa has been attempting to collect information through questionnaires on the use of IT in member ports. Response to this attempt has also been low prompting the Association to plan a series of visits to collect pertinent information.

II. Use of Information Technology in ports

7. The information flow in a port community is illustrated in figure 1 below, provided by the Port of Rotterdam information network (www.per-info.nl e home main.htm). This diagram illustrates the various players and data flows that occur. The two essential players are the freight forwarder and the ship's agent who must coordinate information flows from various sources. The use of information technology will reduce both the amount of time for information exchange and errors occurring from multiple transcriptions of data. Data entry routines can be established to insure information is both complete and logical. For example, routines may specify ranges for values (a container weight must be less than 40 tonnes), or calculating that values correspond to their check digit (container identification number).

Figure 1: Example of information flow in a port (Port of Rotterdam)

8. The development of a port community information system using UN/EDIFACT and free format messaging has been the goal of many ports as a means of speeding-up the flow of information and reducing errors. In a number of ports, concerned departments (customs, port authority) and the business community have established joint companies to develop, install and operate such systems. Examples of these companies include Portel Servicios Telematicos (Spain), CNS Port Community Systems and Maritime Cargo Processing plc (United Kingdom), DAKOSY (Germany), SEAGHA (Belgium), PCR (the Netherlands), ADEMAR2000/PROTIS2001 (France) and PORTNET (Singapore). The primary objective of many of these companies was to create an interface with customs. Subsequently, they have expanded their functionality to send and receive other messages. All these message-switching services now allow for the exchange of information via the Internet. Annex I provides a list of standard EDIFACT messages for use with containers, including messages for communicating with customs.

9. To introduce information technology into a terminal or port, central databases with relevant information to operate a terminal are needed. This is the basis for administrative and operational processes. The databases are accessible to all other software modules that are used to enter, update and extract information. All information provided by an agent, forwarder or shipping line is entered into databases manually or electronically. Information in the databases is used to control operations, for example, at the gate to check all cargo entering and leaving the terminal. The date and time of arrival and departure of all cargo is noted and databases are updated. Once this cargo has been accepted, other software programmes linked to the central databases are able to access the information. It is essential that the databases are kept up-to-date at all times, i.e. each time the cargo is moved the database must be modified. Smaller ports, because of the reduced volume of data, are able to input information manually into the system from information received both from internal and external sources. Data entry is the most critical step and software must be designed making it as accurate, easy and rapid to input as possible. The information in the databases can be used to prepare invoices and standard reports.

10. Database software packages provide facilities to store data and their relationships and provide an effective way for updating and retrieving stored information. The overriding advantage of this is that all users within the organization use the same information. Software packages are supplemented with a number of tools to prepare screens for inputting, retrieving and processing information and facilitating access to databases from other computers. Standard relational database[1] management programmes are used to build this information database. The most popular systems are Oracle,[2] Microsoft SQL Server,[3] Microsoft Access.[4]

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[1] A relational database is made up of a number of tables where each record represents only one thing, such as an object or an event. An example of an object would be a ship, a container or a consignment. Examples of events are ship arrivals, delivery orders and truck arrivals. Each row (record) in a table must be unique with each row having a primary key (a column that contains unique values for a table). A simple key is made up of one column and a composite key of two or more columns. A foreign key is a column in a table used to reference a primary key in another table.

[2] Europe Combined Terminals (ECT) in Rotterdam are using 55 Oracle Rdb (relational databases) to track and guide operations. The databases range in size from 1 MB to 3 GB and are hosted on five Digital Alpha clusters that at operational peaks handle up to 500 transactions per second, see www.oracle.com.

[3] Microsoft's SQL (structured query language) is a high-end relational database management system (RDBMS) for building business applications, see www.microsoft.com/sql.

[4] Microsoft Office database management system provides powerful tools to help organize and share a database. Interactive data access pages provide forms and reports designed for the Web, see www.microsoft.com/office/access/default.htm.

IBM DB/2,[7] Sybase[8] and Informix.[9] The use of database packages is strongly recommended for systems development.

11. For major container terminals, Cosmos N.V.,[10] Navis[11] and Tideworks Technology[12] are three of the main suppliers of relational database software systems. With these database systems as the backbone of operations, various applications manage the use of the container yard and the working of ships. This maximises the use of space and equipment and minimises the turnaround time of ships and inland transport equipment. These systems provide the capability to receive standard messages sent electronically.

12. A large number of other suppliers provide port and terminal operating systems that are scalable and can be used for smaller terminals with the ability to accept and generate EDI messages and accept radio data information from container handling vehicles. The following four are suppliers of these systems: Americas Systems Inc. (www.etermsys.com), Dockside Software (www.docksidesoftware.com), PCR Terminal Systems (www.pcronline.com) and PortTec (3DPORT) (www.discoverjade.com/3dport). The latter two suppliers make extensive use of coloured graphics that will help staff considerably in using the software. The first three companies are US based and the last one is in New Zealand. All systems work on a PC based Local Area Network (LAN).

III. ACIS PortTracker

13. PortTracker is part of the logistics information system, ACIS, for tracking equipment and cargo using computer and telecom equipment. Each application is independent of the other, but is designed with a modular approach to enable the free exchange of data. The aim of PortTracker is to track transport equipment and cargo in and out of ports. There are four basic software modules:

> *Ship Call sub-module*: covers each step of the ship call and can be assimilated to the Harbour Master function. It covers the boarding of the pilot, mobilisation of tugs and mooring gangs, berthing, and occupation of the quay and deberthing. Moreover, it provides a database of ships and international codes (sub-module developed and implemented).

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[7] IBM database with outstanding performance support for very large databases (hundreds of millions of records) handled on multiprocessor (up to several hundreds processors) computers, Internet readiness, runs on non-IBM machines and various operating systems and integrate with other IBM tools, see www-4.ibm.com/software/data/db2/.

[8] Sybase provides the package SQL Anywhere which allows the development of data management applications for the Internet, see www.sybase.com/home.

[9] Informix Foundation.2000 provides a flexible, reliable and easy to deploy Internet platform, see www.informix.com.

[10] Cosmos N.V. markets a wide range of software products and services to optimize the operation of container terminals, as well as ro/ro, cars and general cargo terminals, see www.cosmos.be.

[11] Navis LLC provides container handling software for terminals and shipping lines worldwide in over 150 customer sites in 39 countries, see www.navis.com/home.jsp.

[12] Tideworks Technology is a subsidiary of Stevedoring Services of America that provides tracking and management of container and breakbulk terminals, see www.tideworks.com.

Cargo Handling sub-module: for general cargo/break bulk with assignment of gangs and handling equipment, monitors operations with time sheets and shift reports, utilisation of cargo handling equipment (sub-module under development).

Container Terminal sub-module: An inventory control system, monitoring container movements and handling operations from ship to delivery or vice-versa including storage and where appropriate stripping/stuffing (sub-module under development).

Cargo Transfer sub-module: includes the Manifest Transfer System enabling shipowners/brokers/shippers to electronically transmit manifest data to receiving ports. This module uses an UN/EDIFACT standard manifest message, for the management of cargo from receipt to storage and the gate pass for delivery of the cargo (sub-module developed and implemented).

14. The databases maintained by PortTracker will allow three vital functions to be carried out. *Port billing* to the ships agent and shipper, based on operational information provided by the system. *Port statistics and performance indicators* to port management, based on the operational information, as standard reports at regular intervals and as specific user-defined reports for internal or external needs. *Port interface* allowing operators and clients to exchange data electronically between agents, shippers, customs, stevedores, freight forwarders, road operators, railway, and river transporters. Thus, ACIS is being developed to provide a framework that can be used by port authorities and terminal operators to provide reliable and immediate data on transport operations that permit the improvement of day-to-day management and decision making. ACIS is funded from multi- bi-lateral sources and can be installed in any country requesting it, provided a trust fund is established within UNCTAD.

IV. Information Technology solutions for small ports

15. Although small ports handle less ships and cargo and have smaller information flows, their port authorities still have to exchange information with a large number of parties. Software packages are available that allow for the receipt and sending of EDI messages (computer to computer). As many small ports in developing countries are linked to the Internet, the use of IT linked to the Internet offers the potential to exchange information electronically provided other members of the port community are also linked. With, the rudimentary framework of a port community system in place, the use of e-mail with attachments is one way of transmitting information amongst parties, which may be more appropriate for small ports rather than using standard EDI messaging. If the information is received in electronic form it can be copied rather than re-entered. For IT solutions for small ports, it will be assumed that the initial system will have a human interface for data input and external reporting. Initially, information on ships arriving and in port would be transmitted daily to ships' agents and freight forwarders by fax or e-mail. At a later stage, some of this information could be made available on the port website.

16. The development of an information system must follow a sequence of steps to ensure it will function successfully. The developmental steps are as follows: define requirements; accept a system specification; select a supplier for software and hardware; accept a User's Manual; test the system; train staff to operate the system and install the system. This report will focus on the definition and requirements of information systems to speed-up the flow of goods through a port. The requirements are made up of the objectives, scope, organization of information flow, outputs, inputs, files, controls and standards. Controls deal with checking the accuracy and completeness of information and with who will have access to updating files. In addition, it will be essential to implement a backup system to make copies of the files at regular intervals. The loss of operational information may force the terminal to cease operations.

17. Port authorities will need to maintain information of ships, cargo and containers and services provided to them in a form that can be easily retrieved and shared with various departments in the port. One

of the best ways to improve the management of information is for the port authority to use a relational database package. This software will allow for the development of a number of tables, input screens and reports, facilitating the transmission of messages. The development of these computerized databases in small ports provides cost-effective methods to store and access information and will provide the port with a more reliable and easier to retrieve information improving the quality of service offered. The alternative to developing a system in-house is to select an off-the-shelf system that can be adapted to user requirements. This system will also use a relational database. If the system meets user requirements it could be a more cost-effective system and in all likelihood be operational sooner. One disadvantage is that the port will be tied to the software supplier for modifications and expansion.

18. There are two essential systems to improve the flow of cargo and documentation: namely a ship management and a cargo management system. The information flow to the port authority will be from shipping agents, shipping companies, forwarders and inland carriers. For agents and shipping companies, information will concern which ships are expected, cargo to be discharged, cargo expected to be loaded, loading instructions and delivery and release orders. The forwarder will provide information on the cargo to be delivered to the port and on cargo to be picked up. Inland carriers will provide information on the expected arrival time of trucks at the port with details of the truck and driver. Upon receipt of the information, the port authority will create and/or update a number of relational database tables. These databases will provide information needed for planning and controlling ship and cargo handling operations. The port authority would provide information to the ship's agent including: expected time of berthing, berthing location, containers that have arrived for loading and on completion of cargo working, a list of cargo discharged and a list of cargo loaded. The ship's agent can then inform the forwarder so that he and the receiver of the goods can clear goods with customs, the port authority, etc. and arrange for onward dispatch with inland carriers.

19. A relational database of a system for managing ships illustrating the information needed is presented in Annex II. The objective of this system is to maintain information on all ships expected and to facilitate the planning and control of ship movements and to record information on services provided to the ship. Four main tables and a number of code tables are required for this system. In addition to a register of all ships that have called at the port, information would be maintained on expected ships, ships in port, and services provided to the ship. The ship call table would be updated when information on services provided is entered into the ship services table. This table provides the necessary billing information for all services provided to the ship. This seems a straightforward system where information communicated by the ship's agent to the port authority, via fax or e-mail, would be used to create and update records in the various tables. The Harbour Master will be responsible for this function, as it will be the section receiving and carrying out the requests. This section will also provide information on ships to members of the port community. The availability of a software package VIP (Vessel Identification Package)13 provides a database of vessels in Lloyd's Register of Ships which provides the information needed to create the ship register table. The tables are not meant to be a starting point for system development. They provide a framework that will allow the port authority or operator to maintain information on services provided to ships in port. They help to define the data elements that must be provided and to identify the source of the information. They will also allow for the preparation of client reports and invoices. For example, information in the ship services table linked to the ship call and tariff tables will allow for the preparation of invoices for port dues and ship services.

20. To plan for the working of a ship that will arrive in port, advance information is required on the stowage of the cargo to be worked (the stowage plan) and the ship's manifest. The ship's manifest gives information on the cargo within the containers that includes, for each container, information on the consignment numbers, type and weight of each consignment and shipper and receiver information. The

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13 See www.lmis.com/f-product.htm, the package receives updates every six months.

manifest can be used to prepare an *import consignment table* that will link the consignment to the container or containers in which it is found. Similarly, an *export consignment table* will be created from information provided by the ship's agent and forwarder. The cargo manifest is transmitted to the port authority and customs. The port authority needs this information for determining port dues or charges on cargo, when the type of cargo is the basis of the charge. Customs require manifest information for clearance procedures for customs declarations.

21. For the stowage plan, there is a standard addressing system for the slot locations on a container ship. Accordingly, the stowage plan can be given as a list for each container to be discharged, where each line refers to the location of one container. The list would be preceded by a header with the ship's name, voyage number, ETA and ETD. An example for the stowage of one container follows.

0030484 BRE3NYC024HLCU1234563HLC2022XXXX

Where: Bay 003, row 04 (second row on port side), and tier 84 (second layer on deck)
BRE refers to port of loading, Bremen
3 movement status for the container, this case empty
NYC refers to port of discharge, New York City
024 Container gross weight three digits in 100 kilogram units, 2,400 kilos or 2.4 tonnes
HLCU Container owner code (four characters)
1234563 Serial number of container (six digits plus check digit)
HLC Container operator
2022 Container size and type code
XXXX Reserved for cargo related information, i.e. dangerous goods, temperature range reefer cargo, out-of-gauge cargo (seven characters)

22. Container ships, major shipping lines and terminals use the standard EDI message BAYPLIE allowing for rapid and accurate interchange of large volumes of data (see the Standard Message Development Group (SMDG) website www.smdg.org, for a full description of this message). For electronic interchange of information, an agreement is required between the two parties. An example of an EDI Agreement can also be found at the SMDG website. Rather than using this messaging system, small ports could use the ISO standard for information related to containers on board vessels for telex or fax data transmission (ISO 9711-1&2). This could be a method to assist smaller ports to obtain advanced information. The stowage plan could be attached to an e-mail (for example, as an Excel spreadsheet) or as an attachment to a fax (see figure 2).

23. For this graphic stowage plan, each sheet refers to one bay of the ship with cargo for discharge at the port. Even numbers refer to rows on the port side of the vessel starting at 00, at the centreline if there is an odd number and across the bay at 02 if, there is an even number of containers. A two-digit odd number indicates the position on the starboard side. A two-digit number indicates indicates the vertical or tier position with 02 referring to the lowest point in the ship and 82 referring to the first layer on deck. With this ISO standard, the information on each container is grouped together and the position of this information on the plan refers to the container's location on board as seen when looking from the stern of the vessel. For non-cellular ships, pseudo bays could be used with each sheet again referring to one "bay".

Figure 2
Stowage Plan

EXAMPLE OF CONTAINER SHIP BAY PLAN FOR FAX TRANSMISSION

*Vessel "**SEMARANG**"* *ETA: **2000-05-21*** *ETD: **2000-05-22***

	06	04	02	01	03	05
84		bre1nyc 113h1cu 2348763 h1c2022 d41	bre4nyc 113n1cu 2015415 h1c2011 ot	bre4nyc 120mmcu 1765921 n1c2034	bre4nyc 121h1cu 2765931 h1c2022 w015	
82	bre4nyc 113h1cu 2734793 h1c2011 ot	bre2nyc 125h1cu 2176342 h1c2022 33	bre1nyc 125h1cu 2434451 h1c2011	bre4tam 125n1cu 2067718 oc12012 ot	bre4tam 1241t1u 2734990 oc12012	bre1tam 124h1cu 2443371 h1c2022 d41

bay 03 on deck port/starboard

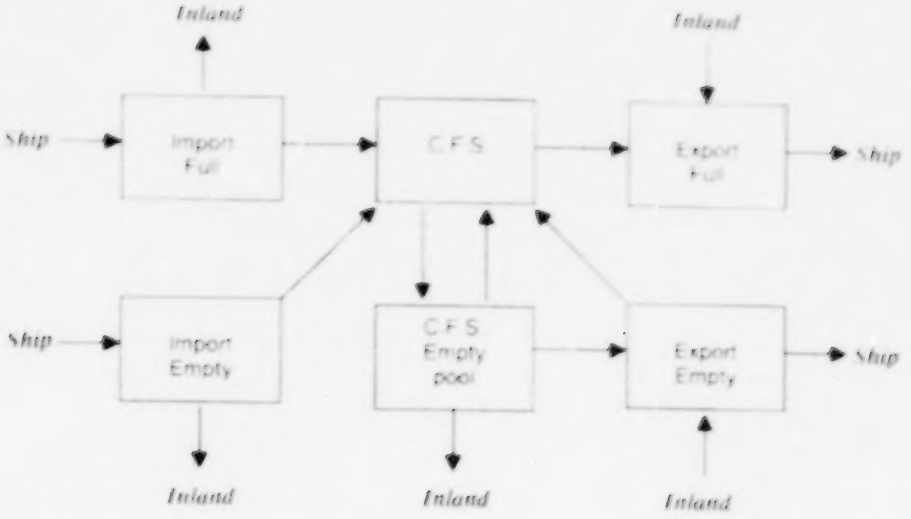
06	bre4tam 203lt1u 2013648 oc12022 o33	bre4tam 210oc1u 2633456 oc12011 c+08+02	bre2tam 213h1cu 2114423 n1c2021 c+08+02	bre1bal 210n1cu 2437882 h1c2022 c+08+02	bre2bal 211oc1u 2467999 oc12011 ot	bre1bal 214mmcu 2011799 h1c2022
04		bre2bal 215oc1u 2987623 oc12022	bre1bal 220lt1u 2067923 oc12011	bre2bal 215oc1u 2987623 oc12022	bre2bal 215oc1u 2987623 oc12022	
02			bre4bal 240i1cu 759049. oc12651 *	bre4bal 223oc1u 2834112 oc12021 d33		
01			bre4bal 228i1cu 769836. oc12651 *			

bay 03 below deck port/starboard

* Half-height containers in tier 02 with ILCU759049 on top and ILCU769836 underneath.

24. As an increasingly expanding percentage of import cargo is flowing in containers, the initial information system should be geared toward container control. The objective of the system is to maintain records for all containers arriving by land and sea, all containers on the terminal and all containers leaving the terminal. This information will assist planning operations and reduce delays. The movements a container can make are shown in figure 3. This is a complex system, as cargo can be stripped (taken out) or stuffed (put in) from the container at the container freight station (CFS). For this case, it is assumed the port will not be handling transhipment containers. There are six tables in the system: import full containers (either FCL or LCL boxes), import empty containers (either for delivery inland or for stuffing with cargo), export full containers (either FCL or LCL boxes), export empty containers (either from inland or from CFS empty pool), containers in CFS (either for stripping, stuffing or stripping/stuffing) and empty containers from the CFS. The information to be recorded in these tables is given in Annex III.

Figure 3
Container flow



25. The information from the stowage plan and manifest can be used to create the *import full and empty containers tables*. Not all information will be available for each container and each record will need updating as the container moves through the port. A stowage plan can be used to prepare the discharge list giving the sequence that containers will be discharged from the ship. The list can then be used to control the operation and confirm that all containers on the list have been discharged. This list can be used to update the two tables.

26. Each time a container is shifted, its current record must be updated to reflect its new location. When a container leaves the port or is moved to the container freight station, the time of movement must be recorded and its location field set to zero. There is a *CFS containers table* and an *Empty CFS containers table* and both have records created each time the container arrives. The empty CFS container table will thus create a record for empty containers that move from the CFS. This record will be completed when the container is moved to a ship for loading, moved to the CFS for stuffing or moved inland for stuffing. The time of the outward movement is recorded and the location set to zero.

27. The database will also be used to maintain information on export containers, both with cargo and empty, expected to arrive by land or from the CFS or the CFS empty pool. Information from freight

forwarders and ships' agents can be entered into an *export full containers table*, listing all containers with cargo that are expected. An *export empty containers table* can also be created for empty containers that are to arrive for shipment or are already in the port. Therefore, information on the ship on which the cargo is to be loaded, the expected date of arrival of the cargo, the inland carrier involved and other details will be recorded as available. For example, for a particular ship, reports can be prepared listing the containers expected to arrive each day. This will facilitate the planning for their receipt and storage, particularly if the time of arrival of the carrier is known. On arrival, the records for these containers are updated and their location in the port noted. The loading list that is provided by the ship's agent is used to update records in the *export full and empty containers tables* and to prepare the loading plan. The containers loaded and the time of loading are recorded and the location set to zero. The list of containers loaded and final stowage plan could be transmitted to the ships agent via an e-mail message.

28. The database can be used for generating standard reports and reports based on specific criteria. For example, it could be used to identify all import containers that have been in the port longer than a specified period. The various forwarders and ships' agents could be contacted by e-mail to inform them of the delay and ask them to expedite the clearance and delivery of the goods. For planning of new facilities, the statistical information on the dwell time of cargo is invaluable for determining area requirements.

29. For containers, the container storage area or yard is marked out into blocks, rows and bays where each location refers to a twenty-foot ground slot (TGS). To locate a container, its TGS and tier location is needed. Each time a container is moved, the record of the movement must be kept, noting the new location with the time of the move. This information is then accessed to update the container position record in the appropriate file as soon as possible. The database can be queried to determine the location of any container. The database can also prepare a list of the position of all containers to be loaded on a specific ship. It could also provide a list for a particular ship's agent of all containers requiring customs clearance.

30. Information technology has been used in the port of The Gambia in West Africa. The Gambia Port Authority (GPA) handled 30,000 TEUs and 394 vessel calls in 1999. The GPA has made substantial investments, mainly for a LAN used with accounting and office automation packages. In addition, GPA has Internet access and is taking a leading role in spearheading an EDI-based port community system. In a bid to further enhance its capabilities, the Authority embarked on the development of a series of programmes aimed at improving the quality of service to its customers. These programmes include, among others, an in-house designed Ports Operations System (POpS). The system is modular and is being developed in stages. Presently the two operational modules are the billing system and the management information system. Other modules under development are the ship operations control system, manifest control system, stevedoring control system, cargo control system, container control system and plant control system. Once completed, the system will be interfaced with other systems, such as the Department of Custom's ASYCUDA (UNCTAD's customs system) and other systems operated by port users. It is expected that this operational system will facilitate the use of EDI for the exchange of information between the port and its users and between the Gambian maritime community and their trading partners worldwide.

31. The GPA is also using the World Wide Web to provide not only general and marketing information to customers, but also to offer port users another channel of enquiry and interaction (www.gamport.gm). The website provides information on the advantages of using the port, working hours, technical characteristics of berths, storage facilities, marine craft, safety procedures, cargo handling equipment, fleet, traffic statistics, vessels in port and vessels due. In addition, GPA plans to expand and enhance its existing internal e-mail system in line with its commitment to fully exploit resources and reduce administrative overheads. This new initiative will involve the installation of a server to provide Internet and e-mail access to essential personnel.

32. In addition to using e-mail to exchange information, port authorities should use professional services to assist in developing a website for the port. The authority must be extremely clear as to the purpose and objective of this form of communication. Its first objective must be to attract new traffic to the port and must therefore include the following essential information:

- Contact information including a name;
- Port facilities (including information on maximum size of ship, draught and length);
- Performance information (average daily productivity, average berthing delay);
- Port tariff information (specific rates can be provided on request);
- Special facilities available such as free port zone and distribution parks.

To better market its services, the port should provide information on performance and tariff levels that is of particular concern to shipping lines. The information on free port zones or distribution parks is more geared to multinational companies seeking to set up a regional distribution centre.

33. In addition to the information that only requires updating on a monthly basis, current information (which needs updating continuously) on ships in port, ships expected, and container tracking, can be made available to the shipping community. This will allow interested parties to instantly check ships expected and in port without having to contact the ship's agent, port authority or operator. Therefore, staff must be assigned to maintain and update information on the website on a continuous basis. Eventually this information can be directly linked to the database in order for routine clients to access this information to determine the status of individual containers.

V. Conclusions

34. The way ahead for small ports in the implementation of information and communication technology seems clear. The Internet's open standards and protocols that allow everyone to connect with everyone else, are the basis of its power and success. The development of programming tools and standards to facilitate the transmission of messages over the Internet are accelerating the interchange of data that can be used in computer applications. As we have seen from the example of the Gambia Port Authority, small ports can take advantage of IT, provided management has a clear strategy to use this technology and allocates sufficient resources. Once a firm IT decision has been made, the following sequential steps should be followed:

1. The appointment of qualified professionals to manage IT implementation;
2. The definition of the requirements of IT systems and the specification of the systems;
3. The evaluation of existing port and terminal operating systems to determine if an off-the-shelf solution will meet port requirements;
4. The development of an implementation plan for the port with quantifiable objectives;
5. The selection and acquisition of new hardware and software (this will most likely be IBM compatible PCs linked together on a local area network running either Microsoft Windows or Linus operating systems);
6. The training of staff to use standard productivity enhancing software (a suite of programmes such as Microsoft Office or Sun StarOffice) for text processing and spreadsheet databases in the various departments in the port to allow for the efficient interchange of information;
7. At the same time the development of applications such as billing, ship and cargo control using a database management system and the training of staff to use these applications;
8. The provision of intranet and Internet access and training to allow port staff to communicate internally and with clients via e-mail and attachments;

9. The provision of web access and training to allow collecting and sending information from and to other websites;
10. The development of a website that initially provides static and then dynamic information on the services offered by the port. There are many one-way communication sites of this type up and running;
11. At the next stage, further development of the website to provide two-way communication, allowing clients to provide new information about themselves (to update databases) and to track specific cargo (access databases);
12. Finally the development of the website to provide a formal, quantifiable exchange of information, for example paying a bill, arranging for pickup or delivery of a container and the exchange of information electronically.

35. The IT implementation decision must be backed up with the necessary resources for the development of applications and with the full involvement of the system users. The ultimate objective is to improve client services. Development work is facilitated by database software tools which permit easy modification, as needs change. The transmission of structured messages electronically via the Internet will rapidly expand. The port must develop or hire staff with the necessary skills to develop applications that are able to use these messages and subsequently to transmit messages to various members of the port community. As expertise develops, the port authority can play a coordinating role in the development of a community system that will speed up and improve the quality of information exchange, reducing delivery delays of goods.

Annex I
UN/EDIFACT standard container messages[1]

BAYPLI
A message to transmit information about equipment and goods on a means of transport, including their location on the means of transport. The message can be exchanged between (liner) agents, tonnage centres, stevedores and ships masters/operators.

MOVINS
A Stowage instruction message contains details of one means of transport vehicle, giving instructions regarding the loading, discharging and restowage of equipment and/or cargoes and the location on the means of transport where the operation must take place.

CALINF
A message from a liner agent to a stevedore that provides information on the planned arrival of a vessel and the expected container operations.

VESDEP
A message from a stevedore to a liner agent informing the latter party of the closing of a vessel's file and giving information on the actual container operations.

COPRAR
A message to order the container terminal that the containers specified have to be discharged from a seagoing vessel or have to be loaded into a seagoing vessel.

COARRI
A message by which the container terminal reports that the containers specified have been discharged from a seagoing vessel (discharged as ordered, overlanded or shortlanded), or have been loaded into a seagoing vessel.

TANSTA
Tank Status Report Message. A message from a vessel to the ship planning department of a shipping line and vice versa (e.g. via satellite), giving details about the contents of ballast tanks, fuel tanks, water tanks and other figures necessary for the calculation of the stability of the vessel.

CODECO
A message by which a terminal, depot, etc. confirms that the containers specified have been delivered or picked up by the inland carrier (road, rail or barge). This message can also be used to report internal terminal container movements (excluding loading and discharging the vessel).

COPARN
The message contains an order to release, to make available, to accept or to call down containers or to announce the impending arrival of containers.

COEDOR
A message to report containers that are in stock of the sending party (i.e., a terminal, depot or container freight station).

COPINO
A message by which an inland carrier notifies of the delivery or pick-up of containers.

COSTOR
Order that specified goods/consignments are to be stuffed into (already or still to be delivered) or stripped from LCL-containers

COSTCO
Confirmation that specified goods/consignments have been stuffed into or stripped from LCL-containers.

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[1] Source: www.smdg.org/documents/smdg_container.htm and www.segha.com.

COHAOR
Order to perform a specified special handling and/or service on containers.

COREOR
Order to release containers, and giving permission for them to be picked up by or on behalf of a specified party.

DESTIM
A message for use by the container repair, shipping and leasing industry. It may be used by a container equipment repair depot to send an owner or user a description of damages to the equipment, as an estimate of the repair actions and costs needed to rectify such damages. A recipient owner may forward the estimate to a lessee. The message may also be used by an owner or lessee as an authorisation message to the repair depot to perform the repairs indicated in the estimate, and as an acknowledgement of his willingness to pay for those repairs indicated in the estimate for his account.

IFTFCC
A message specifying freight, handling and transport costs and other related charges between transport service providers and their customers.

IFTSAI
The function of this message is to request transport schedule or availability information and to answer to such a request.

IFTDGN
The International Forwarding and Transport Dangerous Goods Notification message is a message from the party responsible to declare the dangerous goods (e.g. carrier's agent, freight forwarder). The message is to the party performing the checks in conformance with the legal requirements on the control of dangerous goods, normally the Port Authority. It conveys the information relating to the means of transport such as a vessel, train, truck or barge and on the dangerous goods being loaded, unloaded, and/or in transit.

CUSCAR
This message permits the transfer of data from a carrier to a customs administration for the purpose of meeting customs cargo reporting requirements.

CUSDEC
This Customs Declaration Message (CUSDEC) permits the transfer of data from a declarant to a customs administration for the purpose of meeting legislative and/or operational requirements in respect of the declaration of goods for import, export or transit.

CUSEXP
This message permits the transfer of express consignment data to a customs administration for the purpose of combining all three types of customs reporting (conveyance report, cargo report and customs declaration) within a single message.

CUSPED
This Periodic Customs Declaration Message (CUSPED) permits the transfer of data from a declarant to a customs administration for the purpose of meeting legislative and/or operational requirements in respect of the periodic declaration of goods for import or export. The message may also be used, for example:
- to transmit consignment data from one customs administration to another;
- to transmit data from a customs authority to other government agencies and/or interested administrations.
- to transmit data from a declarant to the appropriate data collection agency on the movement of goods between statistical territories.

CUSREP
This Customs Conveyance Report Message (CUSREP) permits the transfer of data from a carrier to a customs administration for the purpose of meeting customs reporting requirements in respect of the means of transport on which cargo is carried.

CUSRES
This Customs Response Message (CUSRES) permits the transfer of data from a customs administration to the sender of customs data. It may also be used by customs to transmit electronic customs clearance of goods.

Annex II
EXAMPLE OF RELATIONAL DATABASE FOR SHIP MANAGEMENT

SHIP REGISTRY TABLE
Lloyd's register no
Ship's name
Ship type code
Gross registered tonnage
Net registered tonnage
Deadweight tonnage
Length overall
Beam
Draught maximum
Year of build
Flag
TEU capacity
Volume

SHIP'S EXPECTED TABLE
Voyage number
Lloyd's register no
Ship's agent code
Shipping line code
Voyage number (number from the ship's agent)
Expected date/time of arrival
Date/time arrival
Last port of call
Expected time departure
Next port of call
Tonnes to discharge
Type of cargo to discharge code
Tonnes to load
Type of cargo to load code
Number of containers to discharge
Number of containers to load

SHIP CALL TABLE
Voyage number
Lloyd's register no
Ship's agent code
Shipping line code
Voyage number
Position (sea, anchorage or berth number)
Date/time arrival
Draught on arrival
Date/time departure
Draught on departure
Tonnes discharged
Tonnes loaded
Containers discharged
Containers loaded

SHIP SERVICES TABLE
Voyage number
Service item number (sequential number for each service provided to the ship)
Service code
Quantity
Tariff code
Discount
Date/time starting service
Starting position (sea, anchorage or berth number)
Date/time ending service
Ending position

(Service codes refer to services to ship such as berthing, shifting, deberthing, pilots, tugs, bunkering, water, telephone, provisions, etc.)

Annex III
INFORMATION REQUIRED FOR A CONTAINER MANAGEMENT SYSTEM

IMPORT FULL CONTAINERS
Container owner code
Container serial number
Voyage number
Size code
Type code
Dangerous cargo code
Port of loading
Date time discharged
seal number
Condition code
Gross weight
Tare weight
Position (block row bay tier in CY)
Stripping order number
Date time to CFS
Delivery order number
Expected date time of delivery
Date time delivered
Truck license
Driver identification
Custom cleared (Y/N)
Health cleared (Y/N)
Port cleared (Y/N)

IMPORT EMPTY CONTAINERS
Container owner code
Container serial number
Voyage number
Size code
Type code
Port of loading
Date time discharged
Condition code
Tare weight
Position (block row bay tier in CY)
Stripping order number
Date time to CFS
Delivery order no
Expected date time of delivery
Date time delivered
Truck license
Driver identification
Custom cleared (Y/N)
Health cleared (Y/N)
Port cleared (Y/N)

EXPORT FULL CONTAINERS
Container owner code
Container serial number
Voyage number
Size code
Type code
Dangerous cargo code
Loading order number
Port of discharge
Date/time from CFS
Date/time expected to be received (from inland)
Date/time received
Truck license
Driver identification
Seal number
Condition code
Gross weight
Tare weight
Position (block/row/bay/tier in CY)
Date/time loaded
Custom cleared (Y/N)
Health cleared (Y/N)
Port cleared (Y/N)

EXPORT EMPTY CONTAINERS
Container owner code
Container serial number
Voyage number
Size code
Type code
Loading order no.
Port of discharge
Date/time from empty stack
Date/time expected to be received (from inland)
Date/time received
Truck license
Driver identification
Condition code
Tare weight
Position (block/row/bay/tier in CY)
Stuffing order number
Date/time to CFS
Expected date/time of loading
Date/time loaded
Custom cleared (Y/N)
Port cleared (Y/N)

CFS CONTAINERS
Sequence number
Container owner code
Container serial number
Size code
Type code
Position (CFS)
Date/time to CFS
Gross weight
Tare weight
Seal number
Date/time from CFS
Gross weight
Seal number

EMPTY CFS CONTAINERS
Sequence number
Container owner code
Container serial number
Size code
Type code
Position (block/row/bay/tier in CY)
Tare weight
Time/date into empty stack from CFS
Time/date leaving empty stack
Destination (ship/CFS/gate)
Loading order number (if to ship)
Stuffing order number (if to CFS)
Delivery order number (if to gate - inland)

EXPORT CONSIGNMENT
Consignment number
Ship's agent code
Voyage number
Container owner code
Container serial number
Shipper name
Consignee name
Cargo type
No. of packages
Tonnes
Volume

IMPORT CONSIGNMENT
Consignment number
Ship's agent code
Voyage number
Container owner code
Container serial number
Shipper name
Consignee name
Cargo type
No. of packages
Tonnes
Volume